TIMED Solar EUV Experiment (SEE)

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Final Report for FY1996 Phase B Grant to HAO/NCAR

(October 1, 1995 - June 30, 1997)

I. Introduction

The TIMED Solar EUV Experiment (SEE) was designed during FY1996 at the High Altitude Observatory (HAO) at the National Center for Atmospheric Research (NCAR) along with investigators at the University of Colorado (CU), Naval Research Laboratory (NRL), and NASA Jet Propulsion Laboratory (JPL) / Telos Group. The TIMED SEE project moved to the Laboratory for Atmospheric and Space Physics (LASP) at the University of Colorado (CU) in January 1997. The TIMED spacecraft is being designed by the Johns Hopkins University Applied Physics Laboratory (JHU APL) who also serves as TIMED project management.

The SEE science goals are to measure the solar vacuum ultraviolet (VUV) irradiance, to model the interactions of the upper atmosphere with the solar radiation, to study the variability of the solar-terrestrial relationships, and to develop proxy models of the solar VUV irradiance for use at past and future times when direct measurements of the solar irradiance are not available.

The SEE measurement capability is the solar VUV irradiance from 0.1 to 200 nm with approximately 1 nm spectral resolution. Using a 1-axis pointing platform, SEE will observe the Sun for about 3 minutes each orbit.

The subsystems of the SEE instrument are:

1) EUV Grating Spectrograph (EGS)

2) XUV Photometer System (XPS)

3) Microprocessor Unit (MU), and

4) SEE Solar Pointing Platform (SSPP).

II. Final Progress Report for FY1996

The progress accomplished for the FY1996 Phase B grant for TIMED SEE at HAO/NCAR is described below. The period of performance is October 1, 1995 through June 30, 1997, although most of the work was accomplished prior to January 1997.

The EGS, XPS, and SSPP was primarily designed by engineers at HAO. The MU was primarily designed by LASP/CU using a Loral R6000 motherboard. LASP/CU also developed the CODACON detector and its electronics for the EGS.

The highlights of the SEE Phase B activities were the SEE Preliminary Design Review (PDR) in February 1997 and the successful measurement of the solar EUV/XUV irradiance by the TIMED SEE prototype instruments on the NASA rocket 36.135 on May 15, 1997.

The following numbered paragraphs correspond to the Phase B statement of work (SOW) submitted in May 1996. The original SOW task is given, then a descriptive report of the progress for that task is given in italic style.

1. Design Activities

1.1. Complete the few Concept Design Review (CoDR) action items that remain open. We will submit these descriptive results to JHU APL for review.

Our responses to the CoDR action items have been submitted. Most of the CoDR action items are closed now, but a few remain open as JHU APL reviews them.

1.2. Complete the detailed design of the XUV Photometers (XPs) and its Filter Wheel Mechanism (FWM). This design can be completed now that the microprocessor interface to the subsystems is defined. A prototype unit will also be built.

The XPS detailed design was completed by T. Leach (HAO EE) and C. Chambellan (HAO ME) and the prototype unit was built. This XPS unit made a successful measurement of the solar XUV irradiance on NASA rocket 36.135 on May 15, 1997. Final detailed design of the XPS interface to the MU needs to be completed during Phase C/D.

1.3. Complete the detailed mechanical design of the EUV Grating Spectrograph (EGS). The CODACON detector housing detailed design is nearly complete, Hyperfine has been selected as the grating manufacturer, and a Kr lamp source has been selected. The conceptual design of the vacuum door and slit mechanism has been updated, so a more detailed design of these mechanisms will be done along with a detailed design of the grating holder and vacuum housing. The prototype development of the CODACON detector and grating will proceed as purchases at LASP/CU and Hyperfine respectively.

The EGS detailed design was completed by G. Ucker (HAO Sys. Eng.) and the prototype unit was built. This EGS unit made a successful measurement of the solar EUV/FUV irradiance on NASA rocket 36.135 on May 15, 1997. The EGS was calibrated at the NIST Synchrotron Ultraviolet Radiation Facility (SURF-II) in April 1997.

1.4. Complete the preliminary electrical design of the EGS. The detailed design of the CODACON detector electronics is already complete. A schematic of the interface board for the EGS to the microprocessor will be developed along with the designs of the control electronics for the vacuum door, slit mechanism, CODACON HV power supply, and Kr lamp power supply.

The EGS electrical design was done by T. Leach (HAO EE). The CODACON detector electronics and memory interface electronics were built, tested, and integrated onto the EGS housing. These electronics were successful on NASA rocket 36.135 on May 15, 1997. Final detailed design of the EGS interface to the MU, the slit mechanism, and lamp power supply needs to be completed during Phase C/D.

1.5. Complete the preliminary design of the Microprocessor Unit (MU). A Loral R6000 motherboard as been selected for SEE. The instrument interface board that will interface to the microprocessor bus will be designed with serial interfaces to the instruments and a 1553 interface to the spacecraft. The microprocessor engineer at LASP/CU will perform this design under the supervision of our instrument electrical engineer.

The MU design using the Loral R6000 motherboard and custom instrument interface board was done by N. White (LASP EE) and presented at the SEE Preliminary Design Review (PDR) in February 1997. However, after the PDR, the Cassini processor board was selected to replace the Loral R6000 motherboard. The custom instrument interface board remains essentially the same.

1.6. Complete the preliminary design of the Power Regulation Unit (PRU). The power regulation and distribution board will be designed by a HAO electrical engineer.

The PRU was designed by T. Leach (HAO EE) to interface signals and power to the spacecraft and to regulate the spacecraft power and then distribute this regulated power to the SEE components. A Interpoint DC-DC converter was chosen for this PRU design to perform the power regulation.

1.7. Complete the preliminary design of the SEE Solar Pointing Platform (SSPP). The updated concept design for the SSPP uses Schaeffer Magnetics components. Our mechanical engineer will continue to work with Schaeffer Magnetics and APL in designing the SSPP.

The concept design of the SSPP was done by C. Chambellan (HAO ME) using Schaeffer Magnetics harmonic drive, drive electronics, and cable wrap.

1.8. Complete the preliminary electrical design of the SSPP. The details of interfacing the SEE microprocessor to a standard Schaeffer Magnetics harmonic drive electronics (stepper motor electronics) will be developed by the SEE electrical engineer in collaboration with Schaeffer Magnetics.

The concept design of the SSPP electronics was done by T. Leach (HAO EE) using Schaeffer Magnetics hybrid drive electronics with our custom interface electronics.

1.9. Update System Requirements. With updated designs, the SEE system engineer will revise resource tables and spacecraft requirements such as mass, size, power, modes of operation, and data rates.

The updated SEE system requirements was presented at the SEE PDR in February 1997.

1.10. Perform Thermal Analysis. A thermal engineer at JHU APL will perform the preliminary thermal analysis of SEE. With recent changes, the thermal environment for SEE has been simplified in that louvers or radiator plates are most likely no longer required.

The preliminary thermal analysis was completed by J. Ercol (JHU APL Therm. Eng.). The thermal design uses a radiator on the top of SEE and heaters to maintain a temperature during colder conditions.

1.11. Prepare SEE PDR Package. The Preliminary Design Review (PDR) package will be prepared and delivered to JHU APL for review prior to the SEE PDR meeting.

The SEE PDR package was prepared and presented at CU on February 12-13, 1997 with JHU APL engineers attending We decided not to ship this rather large document as part of this report. Instead, we include the review panel listing and the PDR agenda here and will ship this PDR package upon requests.

1.12. Support TIMED NAR Preparation. The SEE information needed for the TIMED Non-Advocacy Review (NAR) will be prepared and presented at the NAR meeting.

The SEE team was not invited to the TIMED NAR, so we did not participate in the NAR held in February 1997.

1.13. Support TIMED S/C PDR Preparation. Revised SEE information needed for the TIMED Spacecraft (S/C) PDR will be provided if necessary.

Six SEE team members attended the TIMED Spacecraft PDR in February 1997.

1.14. Address PDR Action Items. Assuming there will be action items for SEE from the SEE PDR, we will begin to address those action items as resource permits during the remaining part of Phase B.

Considering that the SEE PDR action items did not get distributed until April 1997, we will be responding to these action items during Phase C/D.

2. Documentation.

2.1. Finalize Performance Assurance Implementation Plan (PAIP). Already completed and signed off by HAO / NCAR and JHU APL.

With the move to LASP/CU in 1997, C. Lloyd of LASP/CU also evaluated, revised and signed off the TIMED SEE PAIP.

2.2. Update Instrument Proposal for Phases C/D/E. This proposal is due to NASA Headquarters in July 1996.

LASP/CU submitted the SEE Phase C/D/E proposal in July 1996.

2.3. Update Instrument Calibration Plan (ICP). The ICP will be revised to reflect the changes in instrumentation. The calibration techniques remain the same.

The ICP was updated and distributed to JHU APL engineers. This document is available upon request.

2.4. Update Technical Requirement Specifications (TRS). A significant revision will be done to address a complete specification for each subsystem.

The TRS was updated and distributed to JHU APL engineers. This document is available upon request.

2.5. Draft Software Quality Assurance Plan (SQAP). A similar SQAP for another satellite instrument program at HAO will be modified for the TIMED SEE program.

The SQAP draft was written and distributed to JHU APL engineers. This document is available upon request.

2.6. Draft Acceptance Test Plan (ATP). The Acceptance Text Matrix for SEE will be converted into the ATP.

The ICP draft was written and distributed to JHU APL engineers. This document is available upon request.

2.7. Support development of the SEE Interface Control Document (ICD) by JHU APL. The ICD is a critical document to the SEE program in meeting the expected schedule for the PDR, so we strongly encourage JHU APL to develop the ICD as early as possible in the Phase B.

SEE engineers supported the development by JHU APL of the TIMED General Instrument Interface Specification (GIIS) and the SEE Specific Instrument Interface Specification (SIIS). These documents are available from JHU APL upon request.

3. Travel

The TIMED Science Working Group (SWG) meetings, S/C Technical Interface Meeting (TIMs), and reviews at JHU APL will be supported by SEE investigators, managers, and engineers.

We are planning for travel to California to work with Schaeffer Magnetics on the SSPP and to Virginia to work with Loral in selecting the best processor board for SEE.

All of these meetings were supported by the SEE science and engineer teams.

III. TIMED SEE Cost Summary

The cost summary for the TIMED SEE FY1996 Phase B grant is given on the next page. The most notably difference between the original budgets and the costs is that there was more spent on HAO/NCAR salary than in the original budget and that there was less spent on purchase services. The reason for this difference is that a much smaller subcontract was submitted to the University of Colorado for the SEE Microprocessor Unit (MU) design.